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ACTIVITY-SIZE RELATIONSHIP OF FALLOUT PARTICLES FROM TWO SHOTS, OPERATION REDWING

Research and Development Technical Report USNRDL-TR-314

19 February 1959

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Redwing A&B

installed on the "flight" deck, which was situated on the ship's bow approximately 8 ft above the main deck. The SIC's were so mounted that their sampling ports were located together and exposed flush with the roof of the structure. To reduce wind bias effects, a horizontal steel plate was placed on top of the SIC housing to give an 18-in. overhang on the forward and lateral sides. The opening in the plate for the sampling ports was located forward of the plate center and the plate was greased to prevent those particles falling on the plate from blowing or rolling into the sampling port. Investigators located in the shielded laboratory below controlled the SIC sampling intervals and, immediately after exposure, the trays were lowered by an elevator into this laboratory where analytical procedures were begun.

Particle Selection

Analytical procedures generally were the same at the field laboratory and at NRDL, with minor differences as noted.

Some of the sampling trays exposed during the heavier fallout were examined with a low-power binocular stereomicroscope to determine the size and shape of the particles. Each particle was typed according to shape and sized in situ. Only Shot B particle collections were studied for size distribution. Circular areas were randomly marked on each tray and in these areas, particles larger than 10 μ in diameter were studied. On the YAG-40 trays, a circle 1.2 cm in diameter was used, while a circle 0.6 cm in diameter was used on all other Shot B trays (analyzed at NRDL). No attempt was made to obtain size distribution information from the YAG-40-Shot A particles; these were selected to obtain a sufficient number of particles from all size groups present to provide reliable data.

Immediately after being sized, each particle was carefully scooped up with a hypodermic needle and suspended in a small glass vial for subsequent gamma counting.

Particle Shape and Size Determination

Particles were classified in three general categories on the basis of physical appearance:* spheroidal if spherical in character, irregular if irregular or angular, and dendrite-like when distinguished by an interlacing branching network structure of extreme delicacy (Fig. 1).

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* The color of YAG-40 particles (both shots) was also determined; however, this parameter was not utilized in the present study.

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information regarding the distribution of activity among particles of the same size. Such an approach was employed by Project 2.63[8] in experimental studies at Operation REDWING. During these investigations the activity-size relationships of individual coral fallout particles from two shots, designated as A and B, were studied.*

EXPERIMENTAL PROCEDURE

Experimental design was based on the collection and analysis of single discrete particles; consequently, preservation of individual characteristics was a fundamental collection requirement. Fallout particles were collected on a special sampling surface and the determinations of individual size, shape and gamma activity were undertaken. Procedures were also included to obtain some particle size distribution information, although another project[9] featured this as its primary objective.

Sampling Technique

Fallout particles were sampled by incremental collectors (IC), which are fully described in Reference 8. The collectors sequentially exposed 4 x 4-in. plastic sampling trays, each containing a cellulose acetate disc coated with a heavy layer of special grease; the actual sampling area was 8.2 cm in diameter. For each IC, the exposure period of its trays were identical and preset at either 3, 15 or 36 min, depending on the number of IC's at a station and the expected rates of fallout.

The particles studied were collected at major project sampling stations located on several vessels. For Shot A, only the collection from the YAG-40 was studied. For Shot B, the samples investigated were from YAG-40, YAG-39, LST-611, YFNB-13, and YFNB-29 (two stations). At all stations, project collectors - of which the IC was one type - were located on an elevated wind-shielded platform, designated as a standard platform. Detailed descriptions of the vessels, platforms and their instrumentation may be found in Reference 8. Except for the YAG-40 collections from both shots, the particles investigated were sampled by platform-mounted IC's and shipped back to NRDL for analysis.

In addition to its platform collectors, the YAG-40 had special collecting equipment and a shielded laboratory with facilities to take early-time measurements. Particles for the present study were collected by two adjacent, independently operated, modified IC's designated as special incremental collectors (SIC). These instruments were in a 6 x 3-1/2 x 6-ft housing

* Shot A is the first of the shots in which USNRDL participated during Project 2.63; Shot B is the fourth.

Particle size was described by either of two size parameters, equivalent projected area diameter (D_a) or maximum diameter (D_m). The projected area method is conventional, and the area can be related to particle falling velocity - an important quantity in any fallout model. No significant physical relation can be attached to maximum diameter; however, it does offer ease of measurement and reproducibility. Diameters were measured with ocular micrometers having either a linear scale or a Fairs graticule (sizing circles). The linear scale was employed exclusively to size YAG-40-Shot B particles in terms of D_m. All other Shot B particles and the YAG-40-Shot A particles* were sized by the graticule system in terms of D_a, whereby particle area was compared with graticule area. Measurements were generally taken under a total magnification of 45X, although 19.5X and 9.9X were used occasionally by changing microscope objectives. In general, interpolation between scale units for either micrometer was not attempted, except in the case of YAG-40-Shot A particles.

Particle Activity Measurements

Particles were individually counted for relative gamma activity in a well scintillation counter** employing a 1-3/4-in. dia. x 2-in. thick Tl-activated NaI crystal detector. In the case of measurements made at the site (YAG-40 collections), three 1-min counts were taken and, for convenience, the median was selected as the representative value. Where gross counting rates were less than twice background, single 1-min counting was done. Particles analyzed at NRDL were all counted for single 1-min periods. Backgrounds were on the order of 300 c/m. Experimentally determined coincidence loss corrections were applied when activities exceeded 10^6 c/m. Response characteristics of the several well counters employed were normalized, where necessary, through laboratory gamma standards.

Field measurements were taken from about H + 5 to 40 hr and NRDL measurements from about H + 300 to 650 hr. Activities were corrected to an appropriate reference time for analysis, and experimental decay curves were determined by following the decay characteristics of selected particles and aliquots of particle solutions.

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* A small group of YAG-40-Shot A particles was sized in terms of circumscribed diameter (D_c) by utilizing graticule circumference. Because of its small number, this group was not included in this study but is listed in Appendix A.

** An end-on 1-1/2-in. dia. x 1/2-in. thick NaI scintillator was occasionally used to count exceptionally active particles. A conversion factor of 10 from shelf 1 to well was obtained from lower-activity particles counted in both counters, and has been applied to all results.

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TABLES

FIGURES

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